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INFLUENCES OF LAKE MICHIGAN ON EAST AND WEST SHORE CLIMATES[1]

By CLARENCE BURT ODELL

[Geography Department, University of Nebraska, Lincoln, Nebr., November, 1931]

The influence of Lake Michigan upon the climate of the eastern shore in making it a region favorable to fruit growing is generally understood. However, little in the way of quantitative proof in the form of graphs from weather reports has been attempted. In view of the fact that there is general knowledge pertaining to the differences in climate upon the opposite shores of the lake it has been considered of enough importance to take averages of 15 years of weather reports for stations situated on the east and west shores, in approximately the same latitudes, and to put these results into graphic form. The stations of Milwaukee and Grand Haven were used as one pair and the stations at Green Bay and Ludington as another; thus, the matter of latitude need not be considered, since these pairs are located near the same parallels.

The climatic factors used in the graphs were temperature, wind velocity, number of clear days and cloudy days, precipitation, and the number of days with snow. The number of times that the minimum temperature fell below certain critical points was counted and used in three graphs in order to show which side of the lake is more favorable to fruit culture as far as temperatures are concerned. The critical temperatures for peaches were used, and the estimated damaging temperatures were obtained through consultation with the pomology department of the University of Illinois. A long discussion of each of the graphs and of the why's and wherefore's is not necessary because a study of the figures will bring out very clearly the striking influence of this body of water. Somewhat similar differences are noted between east and west shores at both pairs of stations and these differences in climate may be assigned to the influences of the lake in spite of its relatively small size.

TEMPERATURE

There seems to be a greater range of temperature at the west shore stations—Green Bay and Milwaukee—than at the eastern. (Figs. 5 and 6.) The range, however, is naturally greater at the two northern stations. Grand Haven and Ludington are warmer in the winter and cooler in the summer than Milwaukee and Green Bay. This is due to the winds coming over the water which is cooler than the land in the summer and warmer for the most part in the winter, a result of the difference in the rate of heating and cooling of land and water. There is also a slightly more rapid increase of temperature in the spring and decrease in the fall at Milwaukee and Green Bay than on the eastern shore, due, probably, to the same reason.

The temperature is more nearly uniform at Ludington during July and August than at Green Bay, another apparent water influence. The prevailing wind is south for the two stations during both months.

An attempt also has been made to show how favorable the temperatures are to grow good peach crops on the Michigan and Wisconsin shores of Lake Michigan. Data were taken from the CLIMATOLOGICAL DATA and the following figures were used as the minimum critical temperatures[2] (° F.) which would damage the fruit:

	° F.
January	−15
February	−10
March	5
April	15
May	28

In each of these months for 15 years (1914–1928 inclusive) the number of times was recorded in which the temperature fell below these critical points and the totals were compared. The graphs show the results and it can be seen that Ludington and Grand Haven had fewer killing temperatures and also had more years that were entirely free from damaging temperatures than Green Bay and Milwaukee stations. It does not necessarily follow, however, that the years recorded without such temperatures had good peach crops. Many other factors enter into the production of the fruit—likewise with the other crops grown. Some of these items are wind, rain, soil temperatures, temperatures during the preceding fall and winter, amount of snow covering, amount of sunshine, and humidity. The exposure of the orchard and its drainage, both soil and air, will greatly affect the setting of the fruit. However, the temperature conditions are of fundamental importance to growth, insect flight, rainfall, and humidity.

Figure 1 shows that Green Bay had killing or damaging temperatures in 14 out of the 15 years; Ludington, only 7; Milwaukee, 11 out of the 15; and Grand Haven, only 9. Thus the chances for a damaged crop from too low a temperature are approximately 30 per cent greater on the west shore than on the east. Also the total number of times that the temperatures fell below the critical temperatures were much greater in Green Bay and Milwaukee than at the east shore stations. Here, then, is one important reason why peaches may be grown on the Michigan shore and not on the Wisconsin shore.

However, it must not be assumed that there are no peach crops except in the years entirely free from damaging temperatures. In many of the years when the mercury fell only once or twice below the critical temperature

[1] The weather data used were obtained from the annual reports of the chief of the United States Weather Bureau for the 15-year period of 1914–1928, inclusive. The data used in the section on critical temperatures were obtained from the monthly and daily records found in the Climatological Data (1914–1928, inclusive) for the months of January through May. The Michigan Department of Agriculture furnished data for the actual crop condition or production percentages.

[2] Figures by Dr. J. M. Dorsey, professor of pomology, University of Illinois, Urbana, Ill.

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it would not necessarily damage the whole crop. Perhaps just one section of an orchard or even parts of the trees might be damaged and the rest unhurt. The temperatures as given in the records are for the immediate vicinity of the Weather Bureau station and it is entirely possible that that reading might be found only in the station's instrument shelter. Even in the same orchard, or perhaps on the same tree, air drainage might cause a section to be damaged and the rest to be unharmed. Also, there are so many factors influencing the setting of the fruit that it must not be assumed that there was a perfect peach crop every year in which no damaging temperatures were recorded any more than that the entire crop was destroyed in the years with critical temperatures.

Of course the killing temperatures are different for various fruits but the peach is rather sensitive to low temperatures so that this study may be applied to all fruits grown in the region with some degree of accuracy. The Michigan peach regions center about Ludington and Grand Haven. Hence, the data here used are fairly representative of the conditions in the orchards. Peaches are not grown near Green Bay or Milwaukee and the data obtained from those stations show why that industry would not be profitable there.

Figure 2 (sections A, B, C, D) shows the number of times the temperature fell below the critical point each month for each of the stations. The month of March seems to be the one with the greatest number of times with damaging temperatures. The damage done by the cold in March will depend upon the weather in the preceding months and upon the growth of the tree at the time of the low temperature.

The two graphs (figs. 5 and 6) giving the average temperatures for the four stations show that spring is retarded on the east shore; therefore the trees should not be so far advanced as on the west shore, and hence, a low temperature would not do so much damage to the trees near Ludington and Grand Haven, as on the west coast.

In Figure 3, annual occurrence of critical temperatures, the figures on the right are the number of years during the 15 in which there were the same number of temperature drops below the critical points. This will indicate to a certain degree just how severe the temperatures were for the various years, and also how different the conditions are at the four stations. Thus, in Green Bay we find that in three different years damaging temperatures were recorded fifteen times and that but one year was entirely free. Milwaukee had three with five or more times below the killing point. Ludington had seven years entirely free with but one year as high as five times. Grand Haven had six free years and only two years as many as four times below the damaging point. This all indicates greater freedom from this great danger in western Michigan and the advantage of this section as a peach region over the eastern portion of Wisconsin.

Figure 4 showing the final condition, or production percentages, show some correlation with the last-mentioned one. When the number of occurrences of the critical temperatures goes down, the percentage of production goes up, and vice versa. A few exceptions may be noted, as in 1921, but they may possibly be explained by the other climatic factors. In 1921, however, according to the CLIMATOLOGICAL DATA for January to July, the reports indicate that there was an unusually mild winter. January, February, and March were mild and above normal, but April came in with a cold wave and also had blizzards in the middle of the month over the lower peninsula. Cherries, peaches, plums, apples, strawberries, and garden truck were badly frozen. The report also states that a cold wave came the 15th and 16th of May and that there was some damage since the vegetation was two weeks in advance of the normal season. In this case temperatures might not have been low enough to do harm in ordinary circumstances but due to the advanced season the buds were damaged at a temperature higher than 15° in April and 28° in May. It must be realized that these critical temperatures are only estimates and are used only as a basis for the study. Many variations of temperatures are possible whereby damage will be done to the growing fruit trees.

The fluctuations in production are not affected by temperature alone. The many other factors entering the problem, however, are somewhat dependent upon it. At Least the weather has much to do in bringing about conditions which will damage the fruit crop as well as in bringing about a good crop.

It is rather hard to specifically state how much damage is done to fruit in any one year and to determine an average annual loss. Figure 3 for the individual years shows that there is a great deal of irregularity in the frequency of killing temperatures. Nothing definite is possible in predictions—the place, according to the past weather records, with the greatest chances of being free from low temperature drops can be best used for a profitable fruit-growing region. The many factors entering into this decision makes the problem one of difficulty and yet one of extreme importance financially. Fruit growers want a large percentage of their trees to produce, and they will, of course, gamble with the weather in the places which have the lowest percentage of killing temperatures over a period of years. These graphs were made from past weather reports and should bring out graphically an important reason why the fruit region is where it is, and why the presence of the lake must certainly be an influencing factor in making the climate on the leeward side favorable for fruit culture. A brief account of other weather conditions, as influenced by the lake, follows.

WIND VELOCITY

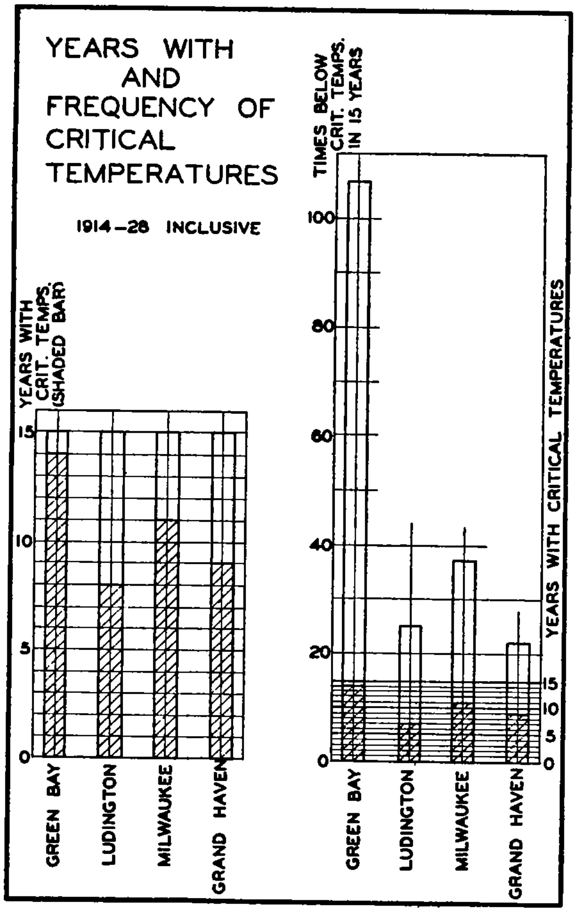
The wind velocity naturally increases in the winter season on both sides of the lake, but the increase is more pronounced on the east side than on the west because of less friction between wind and lake surface (ice or water) than between wind and land. The velocity drops during the summer—to about 9 miles per hour in July and August for the four stations. (Figs. 7 and 8.) The difference in velocity between the two shores of the lake is more pronounced to the north than to the south.

NUMBER OF CLEAR DAYS AND CLOUDY DAYS

Winter is the season of greatest number of cloudy days on both sides of the lake, while summer is the period of greatest number of clear days. (Figs. 9 and 10.) There is a greater annual range in number of clear and cloudy days in the east than on the west side of the lake. December and January each have about seven more cloudy days on the east than on the west shore, while in the summer the difference in number of clear days is not so great. The trend for partly cloudy days would more nearly resemble that of clear than that of cloudy days.

PRECIPITATION

In total annual precipitation there is little difference between the two sides of the lake in the same latitude, but there is a rather striking difference in seasonal dis-



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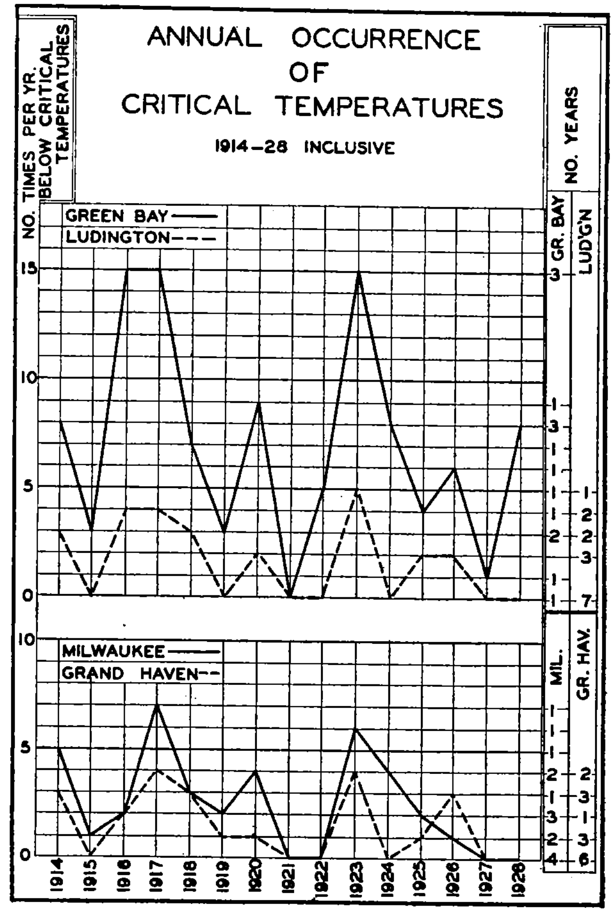

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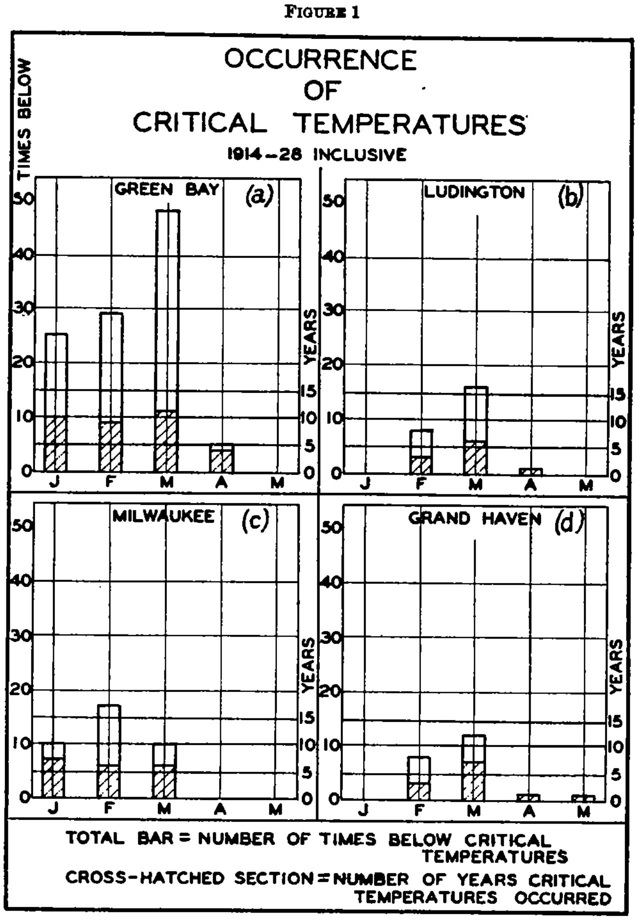

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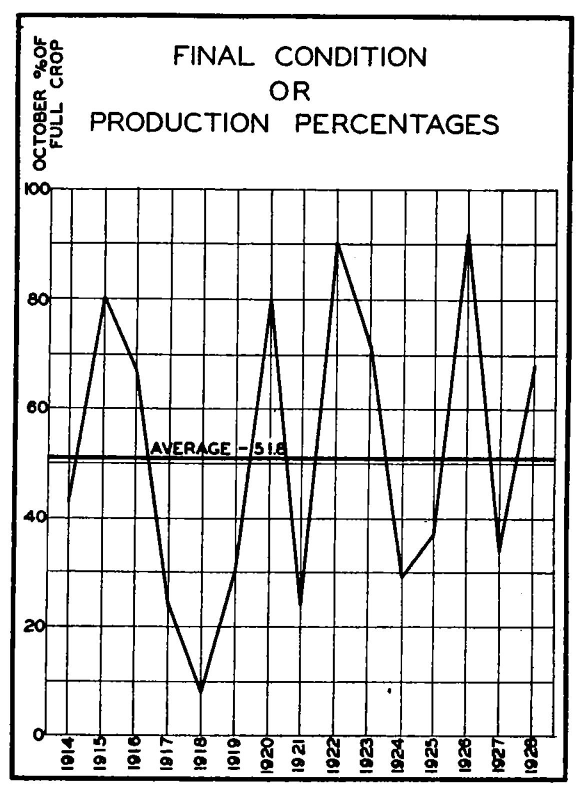

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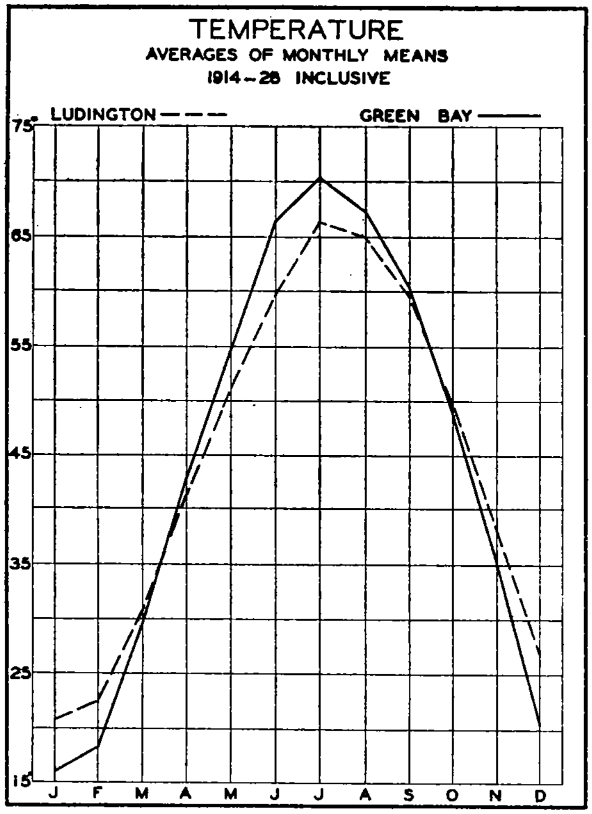

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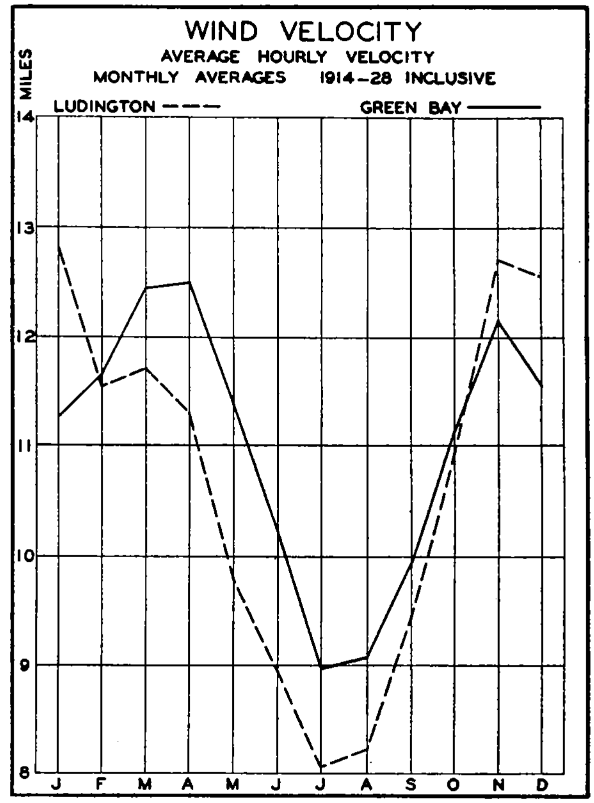

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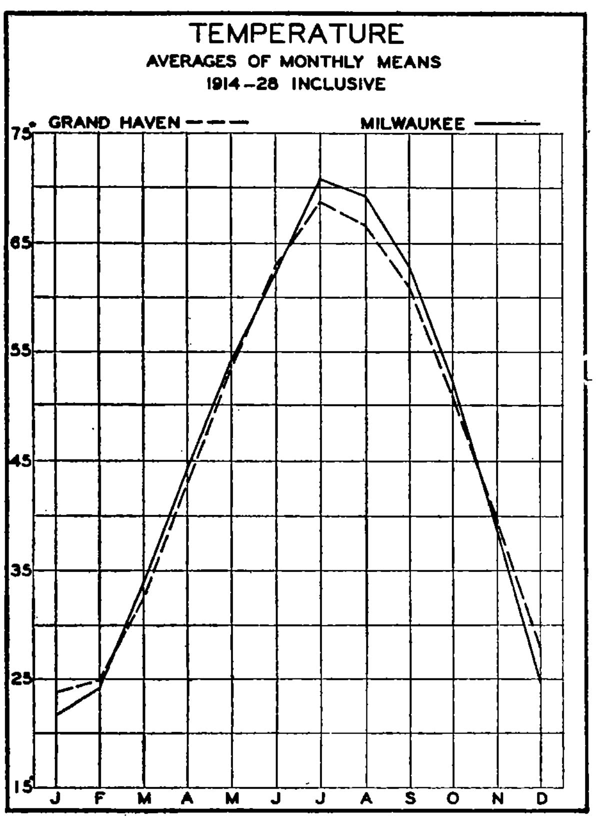

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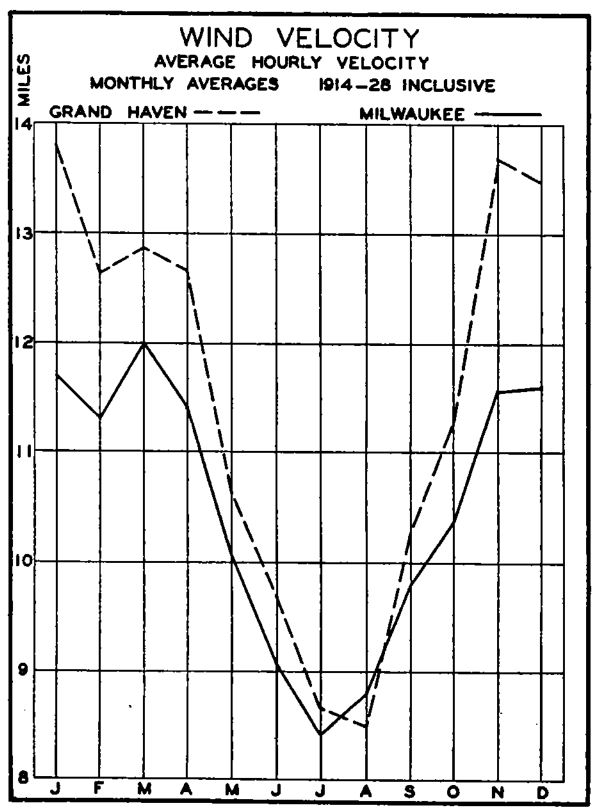

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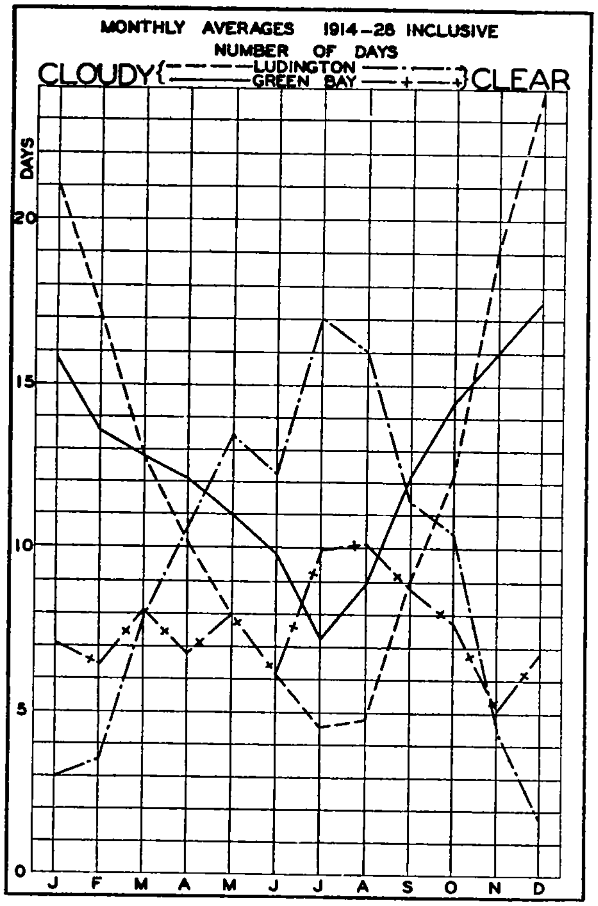

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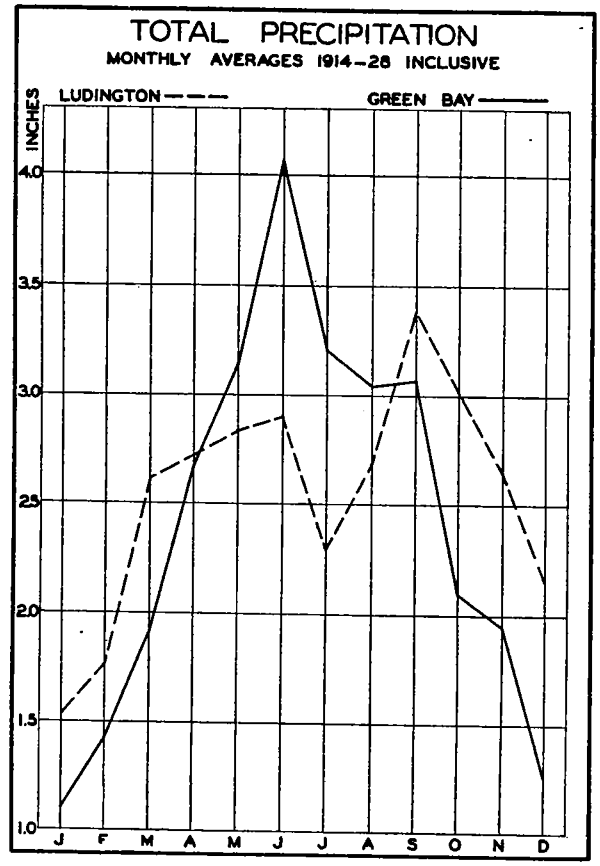

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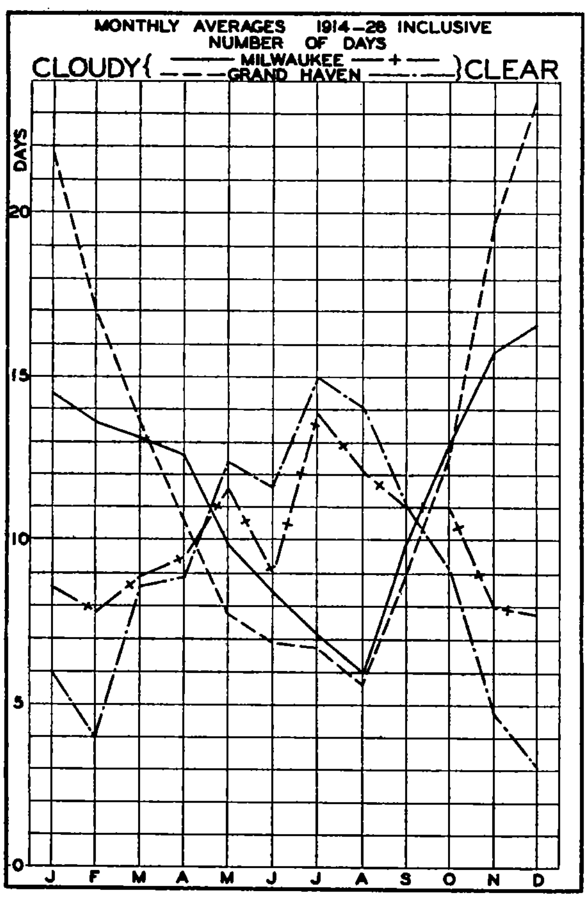

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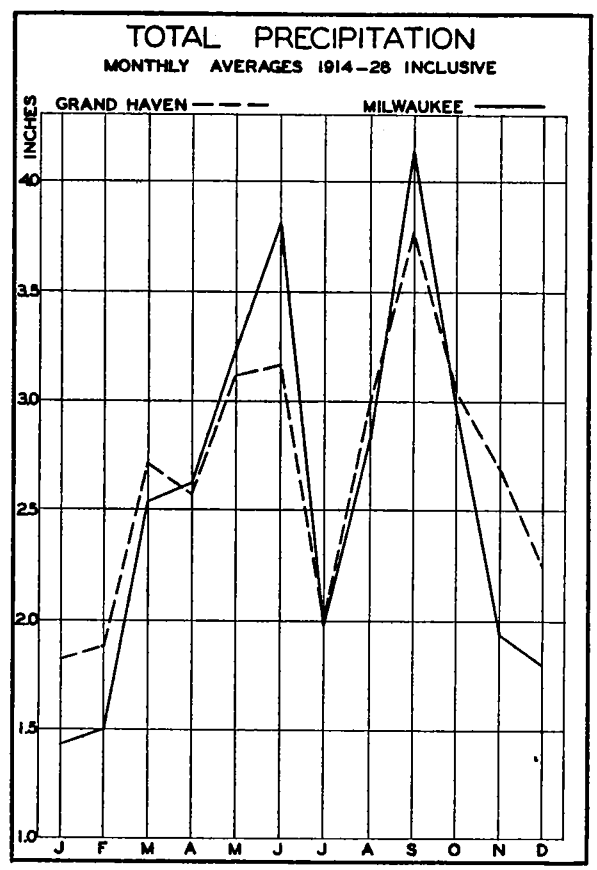

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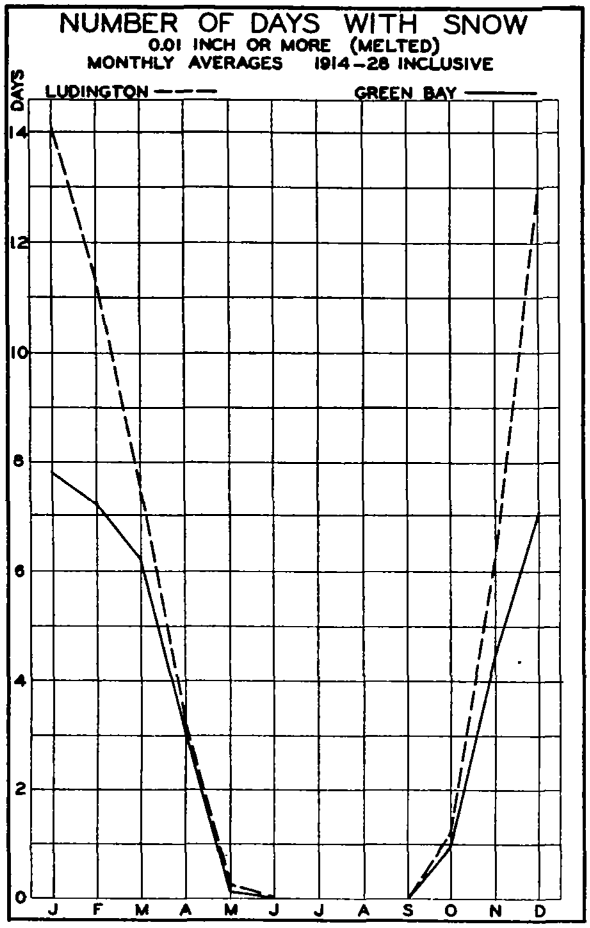

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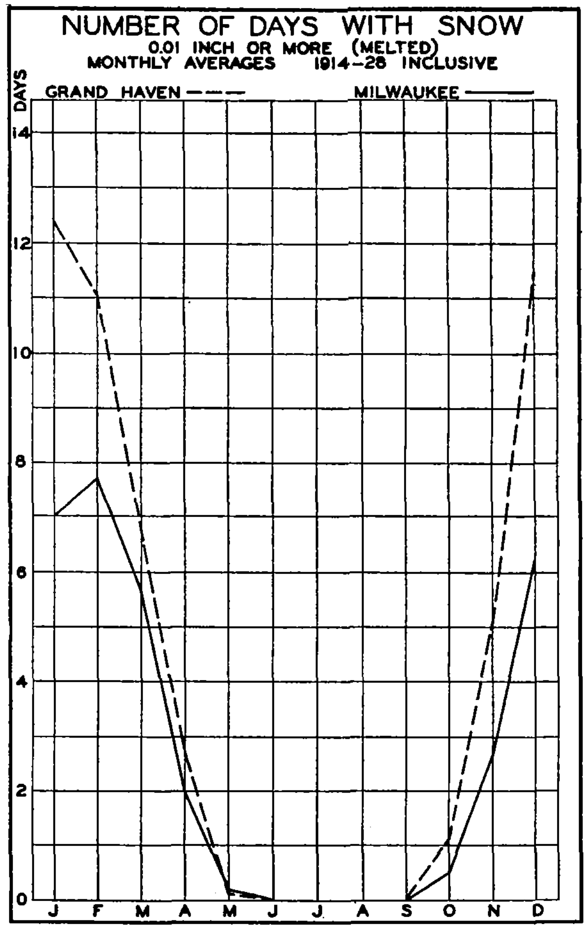

FIGURE 14

tribution. (Figs. 11 and 12.) Though both sides have a maximum in summer, June and September being the rainiest months, the east shore of the lake has a noticeably lower percentage of its precipitation in summer. This again is characteristic of marine climates.

NUMBER OF DAYS WITH SNOW

The greatest number of days with snow is found on the east side of the lake, especially in December, January, February, and March. (Figs. 18 and 14.) In terms of whole months all stations have the same length of snow-free period. The peak comes in January, except for Milwaukee where it is slightly higher in February. February would probably stand out even more prominently had the months been reduced to periods of equal length—30.44 days. West shore stations do not have so abrupt a decrease in the number of days with snow, from January to March, as east shore stations.

SUMMARY

Thus the influences of Lake Michigan upon the climate of its two shore may be summarized into the following statements,

1. There is a smaller annual range in temperature on east than on west shore, with a slight tendency for a delayed maximum. Critical temperatures for peach production are far more numerous on the west shore with March as the peak month on both sides of the lake.
2. There is a stronger winter westerly wind on the east shore.
3. There is a greater annual range in clear and cloudy days on the east shore.
4. There is greater fall and winter precipitation on the east shore.
5. There is a greater number of days with snowfall on the east shore.

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